

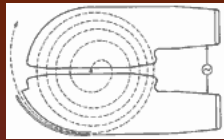
A photograph of a particle accelerator tunnel, showing a circular structure with a grid of lights and a central beam pipe. The tunnel is illuminated with a mix of red, blue, and white light, creating a futuristic and technical atmosphere.

Introduction to Safety Systems in Research Accelerators

Lifecycle Costs

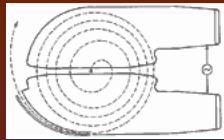
USPAS

June, 2004



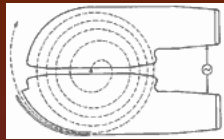
Cost Benefit

- ❖ Method for making risk based decisions
- ❖ Senior management assumes risk of consequences whether they know it or not



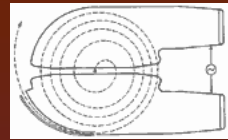
Costs/Benefits

- ❖ Measure of “value”
- ❖ For accelerators this may not be monetary
 - ❖ Cost in Contract Metrics
 - ❖ DART
 - ❖ TRC
 - ❖ Type (n) investigation
 - ❖ Cost can be expressed in operating hours (Availability)
 - ❖ Machine hours
 - ❖ Experiment hours



Human Cost

- ❖ Driven by most senior management
- ❖ Driven by ALARP
- ❖ Regulatory requirements
- ❖ Tolerable Risk
- ❖ Perceived Risk includes ethical judgments



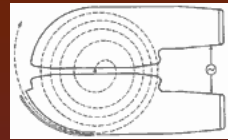
Loss Continuous Functions

$$\text{Cost of failures} = \left[(C_r + C_{lp}) \times (1 - A) \right]$$

C_r – Repair Costs

C_{lp} – cost of lost Production

A – Availability



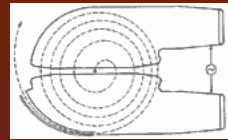
Loss for Event-based Functions

$$\text{Cost of failures} = [C_E \times P(E)]$$

C_r – Repair Costs

C_{lp} – cost of lost Production

A – Availability



Operating Costs

$$\textit{OperatingCosts} = \left[\left(C_{\textit{Change}} + C_{\textit{MAINT}} + C_{\textit{Consumables}} + C_{\textit{Failure}} \right) \times \textit{Lifetime} \right]$$